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PHYSICS.—*Diffraction by a grating.*[1] G. BREIT. Department Terrestrial Magnetism, Carnegie Institution of Washington.

It is known that Frauenhofer interference phenomena may be explained by means of Duane's hypothesis[2] of the transfer of momenta in quanta. According to this explanation, only momenta of amount $\frac{nh}{a}$ may be transferred laterally to a plane grating if a is the grating space. For low intensities of incident radiation the amount of light diffracted into a given order is proportional to the intensity of the incident light. This suggests that the action of a grating is similar to that which would exist if we had simple collisions between light quanta and the grating. However, a consideration of black body equilibrium shows that this is not the case and that the grating is similar in its action to an atom. It seems almost obvious that the actions of a resonator and of a grating are very similar because a conducting rod of a given length forms a transition step between the two.

It is known that the relative intensities of various orders in the diffraction pattern of a grating may be varied within wide limits. This shows that for theoretical purposes we may require that a grating reflecting only within one order should be in proper equilibrium with black body radiation. We postulate that the mean kinetic energy of each degree of freedom of the translational motion should be $\frac{kT}{2}$, where k is Boltzmann's constant and T the absolute temperature. Whenever a quantum is diffracted by the grating, it acquires a

[1] Received March 9, 1926.

[2] DUANE. Proc. Nat. Acad. Sci., May, 1923.
COMPTON. Proc. Nat. Acad. Sci., 9: 359.
EPSTEIN and EHRENFEST. Proc. Nat. Acad. Sci., 10: 133.
BREIT, G. Proc. Nat. Acad. Sci., 9: 238-246, 1923.

momentum laterally of amount $\frac{nh}{a} = \frac{h}{b}$ where $b = \frac{a}{n}$. We further simplify the consideration by supposing that the material of the grating is selectively reflecting at a frequency ν. [This may be shown to be equivalent to assuming that its reflection curve is arbitrary.] We have then that Einstein's[3] coefficient $\frac{\Delta^2}{\tau}$ is proportional to $\frac{h^2}{b^2}$ $\rho(\nu)$, where $\rho(\nu)d\nu$ is the energy density in the frequency range $d\nu$.

Einstein[4] showed that if black body radiation is referred to a frame of reference moving with velocity v, then in a direction making an angle φ with the direction of motion the energy density is to within the first order of v

$$\rho(\nu) + \frac{v}{c}\cos\varphi\left(\nu\frac{\partial\rho}{\partial\nu} - 3\,\rho(\nu)\right)$$

If we suppose now that the diffraction in various directions is determined entirely by the number of hitting quanta and if each element of the grating is capable only of ordinary reflection, Einstein's coefficient R is proportional to $\nu\frac{\partial\rho}{\partial\nu} - 3\,\rho(\nu)$. Hence in order that the equation

$$\frac{\Delta^2}{\tau} = 2RkT$$

(Einstein *loc cit.* 125, form. 12) be satisfied we must have

$$\frac{1}{\rho}\left(\nu\frac{\partial\rho}{\partial\nu} - 3\rho\right) = \text{const.} = \nu\frac{\partial(\log\rho)}{\partial\nu} - 3 \qquad (1)$$

With Planck's form of the radiation law this is clearly impossible (though the Rayleigh Jeans approximation satisfies the above requirement). Hence here just as in the case of atoms (Einstein *loc. cit.*) and free electrons[5] the influence of the presence of radiation on diffraction probabilities must be taken into account. The above-mentioned papers and the paper by Einstein and Ehrenfest[6] indicate how this is to be done. According to the generalization of Einstein and Ehrenfest, Pauli's result may be interpreted to give the probability of scattering as the product of two independent probabilities: (a) The probability of absorption, (b) the probability of re-emission.

[3] Einstein. Zeits. Physik **18**: 121, 1917.
[4] *Loc. cit.*
[5] PAULI. Zeits. Physik **18**: 272, 1923.
[6] EINSTEIN and EHRENFEST. Zeits. Physik **19**: 301, 1923.

For the case of a heavy grating we may simply suppose then that the resultant probability of scattering is such as though the grating were capable of absorbing and emitting as an atom does.

Similar indications are given by the Doppler effect. Schroedinger showed that the Doppler effect may be understood in quantum theory by considering an absorbing and an emitting atom and by bringing into the discussion the changes in the energy of the quantum due to the recoil actions of the atoms. It is clear, therefore, that if a grating is treated as a generalized atom Schroedinger's reasoning will apply and all required conditions will be satisfied. If, however, the purely mechanistic point of view be taken, a difficulty is encountered at once in considering the diffraction by a moving grating. If, for example, the grating be moving with a velocity v towards the incident light and if the the incidence be normal, the angle of diffraction in the frame of the grating should be θ' given by

$$a \sin \theta' = n\lambda'$$

where λ' is the wavelength of the incident light in the frame of the grating. If the grating be stationary

$$a \sin \theta = n\lambda$$

Thus

$$\frac{\sin \theta'}{\sin \theta} = 1 - \frac{v}{c}. \tag{2}$$

On the other hand, if the mechanism of diffraction were always that of imparting the same amount of momentum laterally to the grating as measured in the stationary frame, another angle θ'' would result for the diffraction. This is easily shown to be such that

$$\frac{\sin \theta''}{\sin \theta} = 1 - \frac{v}{c} \cos \theta \tag{3}$$

[To within first powers of $\frac{v}{c}$.]

The disagreement of (2) and (3) shows that the assumption underlying (3) is not valid.

It may be suggested that the grating and the photographic plate should be looked upon as a complex atom. From a purely formal point of view the absorption by such an atom can be calculated by the Correspondence Principle. Similarly for its emission. We consider the latter first. The point of Duane's idea is from this point of view that in addition to the quantum numbers of the emitting atom one

may speak also of a quantum number of the grating, and that diffraction in various directions is given by different changes in that quantum number. This quantum number according to Duane is the momentum of the grating divided by h. Appealing as this picture of Duane's seems to be, it seems necessary to apply it only for phenomena of our complex atom within itself.

BOTANY.—*New Piperaceae from South America and Mexico.* WILLIAM TRELEASE, University of Illinois. (Communicated by E. P. KILLIP.)

Among specimens of South American and Mexican Piperaceae recently submitted to me by the United States National Museum for study the following new species and varieties were found:

Piper austro-mexicanum, sp. nov.

A shrub?; twigs somewhat zig-zag; flowering internodes rather thick and short (3 × 15–30 mm.), granular-scrabrous and rather persistently upcurved-hirsute; leaves elliptic-oblong, subacuminate, rounded at base with one side somewhat shorter, moderate (4–5 × 12–15 cm.), pinnately nerved from below about the middle, the nerves about 6 × 2, scabrous, the lower surface appressed-hairy, somewhat bullate in age; petiole short (scarcely 5 + 3 mm.), upcurved-hirsute, not winged; spikes opposite the leaves, 3–4 × 50–60 mm.; peduncle scarcely 10 mm. long, gray-hirsute; bracts rounded-subpeltate, gray-ciliate; flowers sessile, perfect.

Type in the U. S. National Herbarium, no. 1,209,370, collected at Monserrate, Chiapas, southern Cordillera of Mexico, in 1925, by C. A. Purpus (no. 35).

Piper eglandulosum, sp. nov.

A shrub?; glabrous; flowering internodes long and slender; leaves ovate-elliptic, caudate, equally or subunequally acute at base, 6.5–7 × 15–16 cm., pinnately nerved nearly throughout, the nerves some 10–12 × 2, drying papery and glossy brown; petiole about 1 cm. long, winged at base; spikes opposite the leaves, 4–5 × 70–80 mm.; peduncle rather stout, 7 mm. long; bracts inconspicuous; flowers sessile, perfect.

Type in the U. S. National Herbarium, no. 1,230,811, collected at Carapas, Venezuela, alt. 1680 meters, by G. H. H. Tate (no. 14).

Piper fenianum, sp. nov.

A shrub?; flowering internodes crisp-pubescent, rather slender and short (2–3 cm.); leaves elliptic-lanceolate, subacuminate, acute at base, small (2 × 4.5–4.5 × 7 cm.), palmately 5- or the larger obscurely 7-nerved, glabrous above, crisp-hairy beneath; petiole very short (scarcely 5 mm.) and slender, crisp-pubescent; spikes opposite the leaves, 2–3 × 60–75 mm.; peduncle crisp-hairy, short (scarcely 10 mm.); bracts subspatulate, ciliate and somewhat pubescent; flowers perfect, sessile; berries oblong-ovoid, sulcate, glabrous; stigmas 3, sessile.

Type in the U. S. National Herbarium, no. 1,209,377, collected at Hacienda Fenix, Chiapas, southern Sierra Madre, Mexico, in 1925, by C. A. Purpus (no. 386).

Piper martensianum interior, var. nov.

A form with more lance-ovate leaves becoming 5–8 × 13 cm.

Type in the U. S. National Herbarium, no. 1,209,374, collected at Monserrate, Chiapas, southern Sierra Madre, Mexico, in 1925, by C. A. Purpus (no. 172). *Purpus* 143 is also this.

Piper purpusianum, sp. nov.

A shrub?; glabrous; twigs zig-zag; flowering internodes rather slender, moderately elongated (3–4 cm.); leaves elongated-lanceolate, subfalcately attenuate, subequilaterally rounded below or acute at the very base, moderate (3.5 × 15–5 × 21 cm.), pinnately nerved from below the upper fourth, the strongly upcurved nerves 5–9 × 2, somewhat bullulate in age, paler beneath; petiole rather short (10–20 mm.), winged to the blade; spikes opposite the leaves, small (4 × 20 mm.), with sterile apex scarcely 1 × 10 mm.; peduncle slender and short (scarcely 10 mm.); bracts lunately concave, glabrous; flowers sessile, perfect.

Type in the U. S. National Herbarium, no. 1,209,376, collected at Hacienda Fenix, Chiapas, southern Sierra Madre, Mexico, in 1925, by C. A. Purpus (no. 196).

Piper zarumanum, sp. nov.

A forking shrub, 2 m. tall; flowering internodes rather slender and elongated, appressed- or crisp-pubescent; leaves lanceolate or lance-elliptic, somewhat acuminate, subacute at base, small (scarcely 1.75 × 5.5 cm.), pinnately or submultiple-nerved from below the middle, the nerves 4 × 2, minutely appressed-pubescent or scabrid on both sides; petiole 3 mm. long, appressed-pubescent, winged at base; spikes opposite the leaves, 3 × 30–50 mm.; peduncle 7 mm. long, crisp-pubescent; bracts triangular-subpeltate, ciliate lacerate; flowers sessile, perfect; berries depressed-globose; stigmas 3, small, sessile.

Type in the U. S. National Herbarium, no. 1,196,222, collected between La Chorita and Portovelo (gold mine near Zaruma), Province Oro, Ecuador, alt. 1000–2000 meters, August 28, 1923, by A. S. Hitchcock (no. 21178).

Peperomia carapasana, sp. nov.

A rather tall but slender and straggling glabrous herb; stem scarcely 2 cm. thick; leaves characteristically 3 at a node, lance-elliptic, gradually acute at both ends, moderately large (2.5–4.5 × 9.5–13 cm.), 3- or obscurely 5-nerved, drying thin and translucent; petiole 10–15 mm. long, slender; spikes terminal, filiform (2 × 90–140 mm.), densely flowered; peduncle 15 mm. long; bracts round-peltate; berries ovoid-acute with pseudo-cupule; stigma apical.

Type in the U. S. National Herbarium, no. 1,230,868, collected at Carapas, Venezuela, alt. 1680 meters, in 1925, by G. H. H. Tate (no. 114).

Peperomia choritana Trelease, sp. nov.

A small essentially glabrous herb, repent on logs; stem slender (1 mm.); leaves alternate, round to elliptic, rounded at both ends or the longer acute

at base, 7 × 7–12 mm., drying thick and yellowish with the simple midnerve evident beneath, somewhat revolute, minutely ciliolate upwards, obscurely pale-granular beneath; petiole scarcely 3 mm. long; spikes terminal, 1 × 40–50 mm., somewhat openly subannularly flowered; peduncle filiform, 5–10 mm. long; bracts round-peltate; ovary ovoid, pointed; stigma subapical.

Type in the U. S. National Herbarium, no. 1,196,212, collected between La Chorita and Portovelo (gold mine near Zaruma), Province Oro, Ecuador, alt. 1000–2000 meters, August 28, 1923, by A. S. Hitchcock (no. 21162).

Peperomia enantiostachya distachya, var. nov.

A slender repent and rooting form with ovate-acuminate leaves 2.5 × 5.5 cm., filiform petioles 1–2.5 cm. long, and very small spikes (in fruit scarcely 1 × 15 mm.) paired on a filiform 1-bracted common peduncle 2 cm. long, the individual peduncles scarcely half this length; berries ovoid, obliquely long-beaked, the stigma at base of the beak.

Type in the U. S. National Herbarium, no. 1,197 659, collected at Palmera, Río Pastaza, between Baños and Mera, Ecuador, alt. 1200 meters, in 1924, by G. H. H. Tate (no. 672).

Peperomia omnicola oblanceolata, var. nov.

A moderate short-stemmed subsimple subprostrate herb; stem rather thick (4 mm.), crisp-pubescent; leaves alternate, oblong-oblanceolate, sharp-acuminate, acute at base, moderately large (5–6 × 15–17 cm.), sparsely appressed-hairy above, crisp-pubescent beneath especially on the midrib, rather faintly pinnately nerved; petiole 1–2.5 cm. long, crisp-hairy; spikes 2–4 nearly sessile at each node of an open terminal panicle some 15 × 25 cm., filiform (1 × 100–150 mm.); common peduncle (3–4 cm.) and axis of panicle softly crisp-pubescent; bracts round-peltate; ovary ovoid, impressed; stigma subapical.

Type in the U. S. National Herbarium, no. 1,197,654, collected at Palmera, Río Pastaza, between Baños and Mera, Ecuador, alt. 1200 meters, in 1924, by G. H. H. Tate (no. 667).

Peperomia ppucu-ppucu, sp. nov.

A moderately small (subprostrate?) glabrous herb rooting from many nodes; leaves crowded, about 3 at a node, round-elliptic, rounded at both ends, often emarginulate, drying opaque and without evident nerves, about 10 × 10 mm.; petiole short (2 mm.); spikes terminal, about 2 × 6 mm. rather closely flowered with anastomosing ridges; peduncle short (5 mm.); bracts round-peltate, rather large; berries ovoid-attenuate, with pseudo-cupule; stigma apical.

Type in the U. S. National Herbarium, no. 1,231,071, collected at Ollantaytambo, Urubamba, Peru, alt. 2800 meters, in 1925, by F. L. Herrera (no. 802).

Peperomia stelecophila glabrata, var. nov.

A moderately small repent herb, on logs, rooting from many nodes; stem rather slender (2–3 mm.), glabrous; leaves alternate, ovate, acuminate, peltate distinctly within the rounded base, 2.5 × 4.5 cm. (? or larger), dull, leathery, obscurely multiple-nerved, appressed-hairy around the margin; petiole 3 cm. long, glabrous; spikes axillary (? or also terminating lateral

branches), 3 × 80–90 mm., closely subannularly flowered; peduncle 25 mm. long, bracted near the middle; bracts round-peltate; berries oblong, truncate with stout spreading beak; stigma on the truncated apex.

Type in the U. S. National Herbarium, no. 1,196,573, collected between Baños and Cashurco, Valley of Río Pastaza, Province Tungurahua, Ecuador, alt. 1300–1800 meters, September 25, 1923, by A. S. Hitchcock (no. 21886).

Peperomia subanomala, sp. nov.

A rather small erect branching herb; stem slender (1–2 mm.) rather long-hairy but glabrescent except about the nodes; leaves opposite, elliptic, subacute at both ends, rather small (7 × 14–10 × 20 mm.), slightly pubescent on the nerves above, somewhat revolute, densely long-hairy beneath, obscurely 3-nerved, firm and opaque; petiole short (2 mm.), hairy or subglabrescent; spikes terminal and axillary, moderately small (1 × 30 mm.), rather closely flowered; peduncle 5 mm. long, glabrous; bracts round-peltate; ovary ovoid, impressed; stigma subapical.

Type in the U. S. National Herbarium, no, 1,197,533, collected at Ambato, Province Tungurahua, Ecuador, alt. 2500 meters, in 1924, by G. H. H. Tate (no. 542).

Peperomia subconcava, sp. nov.

A moderately small more or less cespitose simple erect arboricolous herb; stem rather slender (scarcely 2 mm.), at first puberulent or glabrous; leaves about 3 at a node, round-elliptic or obovate, rounded at both ends or the base subacute, very fleshy, drying thick with hyaline margin and not obviously nerved, 10 × 10–15 mm., somewhat pubescent to quite glabrous; petiole short (3 mm.) and thick, granular-puberulent or glabrous; inflorescence unknown.

Type in the U. S. National Herbarium, no. 1,196,467, collected between Cuenca and Huigra, Provinces Azuay and Cañar, Ecuador, alt. 2700–3000 meters, September 12–13, 1923, by A. S. Hitchcock (no. 21686).

Peperomia tequendamana, sp. nov.

An ascending moderately small more or less branched herb; stem moderate (2–3 mm.) with short internodes, rusty crisp-villous; leaves alternate (? exceptionally opposite), broadly elliptic or ovate-elliptic, obtuse at both ends or abruptly blunt-acuminate, moderate (1.5 × 2–2 × 4 cm.), 5-nerved, appressed-hairy on both faces, granular beneath; petiole very short (2 mm.), hairy; spikes terminal and axillary, 2 × 60 mm., rather loosely subverticillately flowered; peduncle about 10 mm. long, from sparsely crisp-pubescent glabrescent; bracts round-peltate; ovary impressed, ovoid, obtuse; stigma subapical.

Type in the U. S. National Herbarium, no, 1,198,754, collected at Tequendama Falls, near Bogotá, Dept. Cundinamarca, Colombia, September 1909, by Brother Ariste Joseph (no. B-92).

BOTANY.—*On* Gyranthera *and* Bombacopsis, *with a key to the American genera of* Bombacaceae. H. PITTIER, Caracas, Venezuela.

In his recent revision of the *Bombacaceae*,[1] Mr. R. C. Bakhuizen van den Brink has confessed himself unable to place my genus *Gyran-*

[1] *Revisio Bombacearum*, in Bull. Jard. Bot. Buitenzorg, Ser. III, **6**: 161–232; *pl. 26–38.* 1924.

Fig. 1—Flowers of *Gyranthera: A-C*, general views showing details of the petals; *D*, calyx; *E*, anther with the connective stipitate and auriculate at the base, long awned at the apex. All about ½ dia.

thera, described in 1914 from specimens of the Panaman species.[2] In 1921[3] I published a second species, *Gyranthera caribensis*, in a paper in which I gave all the additional details necessary to characterize the new genus definitely, and to place it rightly among the *Bombacaceae*. If the author had consulted this paper, presumably accessible to him, the description of the fruit alone would have convinced him that *Gyranthera* really belongs to the *Bombacaceae*, and further that it is not to be associated with *Chorisia*.

In order better to establish the status of *Gyranthera* as a valid genus, its description is given here again, emended and amplified so as to show more clearly the characters which differentiate it. The illustrations, reduced to one-half natural size, show the principal features of the flower and fruit.

DESCRIPTION OF THE GENUS GYRANTHERA PITTIER (1914)

Flores regulares vel leviter zygomorphi. Calyx coriaceus, tubulosus, caducus, plus minusve regulariter 2 vel 3-lobulatus, lobulis perbrevibus, integris bicuspidatisve, in aestivatione valvatis. Petala 5, laciniata, crassa, basi, tubo stamineo adnata, prefloratione contorta. Tubus stamineus teres vel sulcatus, elongatus, gracilis, longe exsertus, apice versus staminodiis lineari-filiformibus plus minusve sparsis appendiculatus; filamenta 5, crassa, antheris permultis, vermiformibus, dithecis obsita; thecae transverse septatae; connectivum basi subsessile vel distincte stipitatum, apice emarginatum ongeque mucronatum; pollinis granula pallide flava, laeves, diminuta. Ovarium superum, sessile, 5-carpidiatum, 5-loculare; ovula transversa, anatropa, angulo interno locularum affixa; stylus filiformis, stamina longior, stigmate breviter 5-fido. Capsula plus minusve fusiformis, unilocularis, coriacea vel sublignosa; dehiscentia loculicida. Semina numerosa, alata, albuminosa; embryo leviter curvatus.

Arbores sylvarum panamensium et venezuelensium, altae, deciduae, inermes. Folia alterna, 3-7-digitata, longe petiolata, foliolis integris, petiolulatis. Flores magni, albi, ebracteati, in panniculas terminales, unilaterales, dispositi.

From this description it will be seen that *Gyranthera* differs fundamentally from *Chorisia* in its capsule, in which the ovarian cell-walls have been almost completely ob'iterated; in the shape and disposition of the winged seeds; and especially in the general structure and appearance of the flower. The same conclusion may be more quickly reached by comparing plate 40 of volume 12, part 3, of Martius's *Flora brasiliensis* with the illustrations added to this article. The affinities of the new genus are evidently with the *Matisiae*,—I would say with *Quararibea* and *Ochroma* with regard to the floral

[2] *Malvales novae panamenses*, in Repert. Nov. Sp. Fedde 13: 318. 1914.

[3] *Acerca del genero Gyranthera Pittier*, in Bol. Com. Ind. Venezuela 13: 417–433. 1921.

structure, and with *Bernoullia* as to the fruits. But our plant differs from all three in its digitate leaves and from each in particular by decidedly aberrant characteristics, such as the presence of staminodes disposed in two more or less regular whorls, each staminode simple or bifurcated in the upper whorl, bifid or trifid in the lower whorl. The arrangement of the seeds also is remarkable and *sui generis:* while in *Bernoullia,* the wings are simply turned upward at the base and downward at the apex of each cell of the capsule, in *Gyranthera* they are so placed in the single cell that two consecutive wings of the lower seeds are separated by the wing of one of the upper ones. This is neatly shown in figure B, of the accompanying Fig. 2.

The above description is far from perfect. The arrangement of the anthers, on account of their peculiar gelatinous consistency when fresh, has not yet been sufficiently elucidated. The fruit of the Panaman species is not known. But it seems that there can be no doubt as to the validity of the genus and its place in the classification, somewhere between *Quararibea* and *Bernoullia.*

Mr. Bakhuizen van den Brink also ignores the genus *Bombacopsis,* published by me in 1916, based on *Pachira Fendleri.*[4] I am quite aware that any botanist who is reduced to mere herbarium specimens or scanty descriptions upon which to base his judgment may hesitate to accept any further splitting of the genera *Bombax* and *Pachira.* Schumann himself even went so far as to unite these two last groups into a single one, *Bombax,* thus going back to the Linnean generic concept. This, however, has not generally been accepted, and most botanists admit that there is at least a decided difference between the two groups. They are as a matter of fact separated by fundamental differences in the fruit and seed, and by no small structural details of the flowers. Without going farther into details, let us recall the presence or absence of wool in the fruit and the considerable size of the seeds of *Pachira* as compared with those of *Bombax.*

In the course of my explorations in Panama, my attention was drawn to two striking trees, originally placed among the species of *Pachira,* the one by Seemann under the name of *P. Fendleri,* the other by Bentham as *P. sessilis,* and transferred to *Bombax* by subsequent authors. The flowers of these two trees look exactly like miniatures of those of the genus *Pachira* and, as the fruits had not then been described, both botanists were to a certain extent justified in the generic place assigned to these species. But when the fruits became known, they proved to have the structure of those of *Bombax,*

[4] Contr. U. S. Nat. Herb. 18: 159-163, *pl. 64-75* 1916

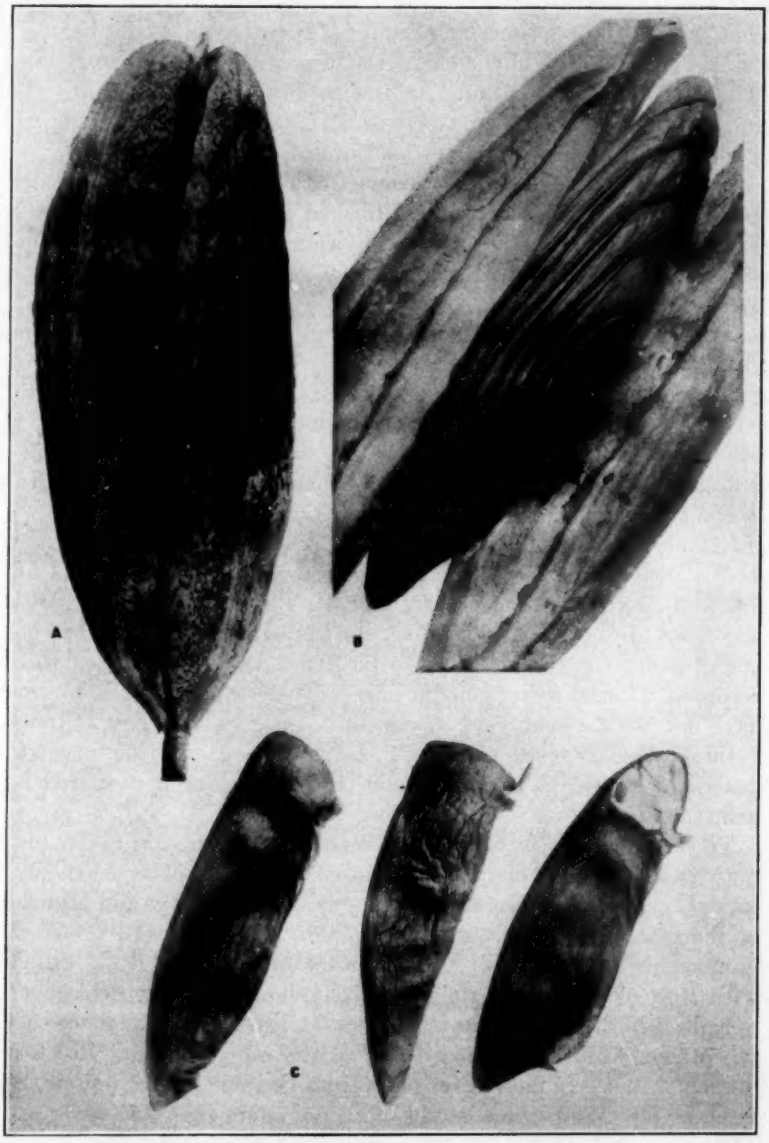

Fig. 2—Fruit of *Gyranthera: A*, capsule before dehiscence; *B*, part of open capsule showing arrangement of seeds; *C*, detached seeds, one open to show details of embryo. Same reduction as in Fig. 1.

with small seeds imbedded in the wool depending from the pericarp. That is to say, these trees, on account of their fruits, do not belong to *Pachira* nor, because of the characteristics of the flowers, to *Bombax*. In other words, they belong neither to *Bombax* nor *Pachira*. The simplest solution was, then, to create an intermediary genus, and this is what I did under the name *Bombacopsis*.

As a general rule, I do not believe in the multiplication of generic names at the expense of well-established groups, but that there are cases when the necessity of the division becomes more and more obvious. Two good instances have attracted my attention in the course of an experience of nearly forty years in neotropical botany. I refer to the genera *Pithecolobium* and *Cassia*. When one comes to know the species of the first by daily observation, ordinary common sense leads one to separate them into several groups. There is certainly no macroscopic likeness between a *Pithecolobium* of the *unguis-cati* group and the rain-tree (*P. saman* Benth.); and again, it is difficult to see the direct parental connection of the latter with the sections *Caulanthon* and *Chloroleucon* as created by Bentham.

I think that Merrill was right when he proposed to make *Pithecolobium saman* the type of the distinct genus *Samanea*,[5] and so I have followed him in naming several recently described species. Britton and Rose are now trying to effect an analogous division in the compound genus *Cassia*, and it is to be hoped that their views will be accepted, at least along general lines. These same authors, however, have not always been very moderate in their views. Few botanists, I think, would agree to accept their extreme splitting of certain genera of *Cactaceae*, in which each section has been proposed as a genus.

To return to *Bombacopsis*, let us repeat that in this group the flower, notwithstanding its likeness to that of *Pachira*, differs markedly in its size, in the longer and narrower calyx, in the number and branching of the stamens, as well as in the wool-bearing fruit and the smaller dimensions of the seeds. On the other hand, if the fruit compares with that of *Bombax* in its general characteristics, the dehiscence is apical with the valves, coriaceous or at least thin, adhering to the receptacle, while in *Bombax* these valves are woody and thick and detach themselves piece after piece from the fruit. The flowers, also, have at most 200 stamens and often not more than 75, while up to 1400 have been counted in some individual *Bombax* flowers.

These are the more distinctive botanical features which separate

[5] This JOURNAL 6: 47. 1916.

the three genera. But in the field nobody would confuse a *Bombax* tree, with its relatively short, thick or ventricose trunk, nor a middle-sized, leafy *Pachira*, with the often enormous individuals of *Bombacopsis*, with its straight column or trunk and sparsely leaved crown towering among the highest in the forest. In *Pachira* and *Bombax* the wood is white and soft and the bark smooth; in *Bombacopsis* the core of the former is reddish and much harder, and the bark, rough and rimose, is often covered with numerous, stout aculei. More details and many illustrations will be found in the place of the original description.

As is natural, I have expanded on the two genera *Gyranthera* and *Bombacopsis*, because, as my own creations, I had their defense very much at heart. It seems almost impossible not to recognize the validity of *Gyranthera;* and as to *Bombacopsis*, which I find necessary as a transitory link between *Bombax* and *Pachira*, its acceptance depends mainly upon whether the two latter genera remain separated, as seems best, or whether the view of Schumann is to be maintained. Most American botanists adopt the former view and so does Urban in his Symbolae Antillanae[6] and Mr. Backhuizen in his "Revisio."

In the latter we note the presence of genus *Montezuma*, as "arbor mexicana." As shown by Standley and Urban[7] as early as 1921, the species probably was never found in Mexico and is identical with the Porto Rican *Thespesia grandiflora*, the type of Urban's new genus *Maga*. *Montezuma* is recognized as belonging to the *Malvaceae* and must be dropped from the *Bombacaceae*. On the other hand, Backhuizen does not mention *Spirotheca*, separated from *Ceiba* prior to 1924 by Ulbrich,[8] who also described in October of that year another Austro-American genus *Septotheca*.[9]

As known today, the American genera of the *Bombacaceae* may be tentatively keyed as follows:

Fruit capsular, dehiscent, large, 5-celled or, in one case 1-celled on account of the disappearance of the walls; calyx caducous; seeds numerous. Seeds round and smooth, exalate; leaves digitate or, in one case, palmate (*Bombacineae*)

Seeds large (1.5 cm. in diam. or more), imbedded in the fleshy dissepiments of the endocarp; flowers large and long (up to 35 cm.); stamens numerous; filaments repeatedly dichotomous; leaves digitate.....1. *Pachira*

[6] Vol. 8, page 427.
[7] Notizbl. Bot. Gart. Mus. Berlin 7: 543. 1921.
[8] Ibid. 6: 160. 1914.
[9] Ibid. 9: 128. 1924.

Seeds small (not over 1 cm. in diam.), surrounded by wool derived from the endocarp.
Fertile stamens numerous, the upper part of the filaments free, simple or bifurcated, without appendices or staminodes.
Flowers slender and long (up to 15 cm.); stamens 75–200; capsule ovoid or pentagonous 18 cm. long or less....2. *Bombacopsis*
Flowers thick and short, the stamens very numerous (up to 1400); capsule fusiform, 15 cm. long or more.....3. *Bombax*
Fertile stamens 5 or 10, more or less adnate; staminodes sometimes present.
Stamens 5, the upper part of the filaments free.
Calyx 3–5-lobed; anthers simple, certain species with staminodes.....4. *Ceiba*
Calyx truncate; anthers double; no staminodes....5. *Spirotheca*
Stamens with the filaments completely adnate.
Anthers 10, straight; gynophor with a cuff-like whorl of 5-bifid staminodes; leaves digitate.....6. *Chorisia*
Anthers 5, vermiform; no staminodes; leaves palmate-lobed.....7. *Ochroma*
Seeds winged; calyx more or less regularly 2–5-lobed; leaves digitate (*Gyranthereae*).
Capsule 1-celled, with 8–12 seeds in all; staminal tube closed nearly to the apex; anthers vermiform; staminodes present....8. *Gyranthera*
Capsule 5-celled, with 8–12 seeds in each cell; staminal tube split open almost from the base; anthers short, oblong; no staminodes. 9. *Bernoullia*
Fruit drupaceous, samaroid or capsular, but small; seeds 1–5; calyx mostly persistent; stamens mostly adnate, the anthers 1-celled; leaves simple, trinerved (*Matisiae*).
Stamens united in 5 bundles; fruit samaroid.....10. *Cavanillesia*
Stamens united in a single tube.
Staminal tube very short, the upper part of the filaments free and bearing a simple anther; fruit capsular.
Calyx truncate; filaments evenly thin.....11. *Hampea*
Calyx 5-partite; filaments thicker toward the apex....12. *Catostemma*
Staminal tube long, more or less deeply 5-partite at the apex, this covered with sessile anthers.
Staminal tube with 5 apical teeth; anthers 30–40; fruit subcapsular. 13. *Quararibea*
Staminal tube 5-branched at the apex.
Anthers 6–12, ovate-oblong, undivided; fruit drupaceous. 14. *Matisia*
Anthers more numerous, vermiform, irregularly divided into several cells.....5. *Septotheca*

BOTANY.—*New South American Verbesininae.*[1] S. F. BLAKE, Bureau of Plant Industry.

Of the thirteen new species of South American Verbesininae described in this paper, seven are based on specimens from the extensive collections made in northern Peru by J. Francis Macbride and William Featherstone on the Capt. Marshall Field expeditions sent out by the Field Museum of Chicago. Three of the others are from a small collection made by G. H. H. Tate, of the American Museum of Natural History, in the mountains of northeastern Venezuela, and one is from the Colombian collections of Dr. F. W. Pennell. The two remaining species are based on old specimens in the Kew Herbarium, collected by William Purdie and A. Mathews in Colombia and Peru respectively, and lent the writer for study by the Director of Kew Gardens, Dr. A. W. Hill.

Jaegeria axillaris Blake, sp. nov.

Small glabrous herb, repent at base; leaves lance-elliptic, connate-clasping, serrulate; heads small, solitary, axillary, on peduncles shorter than the leaves; rays 5, usually shorter than the narrowed tips of the phyllaries.

Perennial (?), 15 cm. long or less, light green, simple or sparsely branched, repent below, the tips apparently ascending; internodes 3 to 30 mm. long; leaves opposite, lance-elliptic, 1.2 to 1.8 cm. long, 3 to 7 mm. wide, narrowed to the callous obtuse apex, cuneate-rounded and connate at base, remotely serrulate with blunt callous teeth or subentire, 3-pli- or 5-plinerved and reticulate (the veins conspicuous in transmitted light); peduncles slender, erect, 3 to 10 mm. long; heads 3.5 to 4 mm. high, 2.5 to 4.5 mm. wide; phyllaries 5, lance-ovate (in their natural position), with subherbaceous 3 to 5-nerved body, glabrous dorsally, hirsute on the sides, and thin scarious ciliate margins infolded about the achenes, abruptly contracted above, and more or less 3-lobate, the central lobe subherbaceous, triangular, acuminate to an obtuse apex, erect to spreading, 1 to 1.5 mm. long; rays 5, light yellow, fertile, essentially glabrous, the tube 0.4 mm. long, the lamina suborbicular, 1.2 mm. long and wide, 3-dentate, 3 to 5-nerved; disk flowers 8, their corollas pale yellow, sparsely pilose on tube, 4 or 5-toothed, 1.5 mm. long (tube 0.4 mm., throat campanulate, 0.8 mm., teeth deltoid, 0.3 mm.); pales broad, abruptly short-pointed, erose above, about 7-nerved, 3.5 mm. long; ray achenes oblong, 2.2 mm. long, obcompressed, blackish, glabrous, bearing a callous half-collar 0.1 mm. high at apex; disk achenes compressed or subquadrangular, 2.2 mm. long, blackish, glabrous, bearing a very short apical collar.

Type in the herbarium of the New York Botanical Garden, collected in wet meadow southwest of Las Cruces, Bogotá, Dept. Cundinamarca, Colombia, alt. 2600–2700 meters, September 24–25, 1917, by F. W. Pennell (no. 2171). Duplicate in U. S. National Herbarium, no. 1,042,157.

When the internodes are short and the leaves crowded the plant is suggestive of *Aphanactis jamesoniana* Wedd. in appearance.

[1] Received March 9, 1926.

Aphanactis villosa Blake, sp. nov.

Cespitose perennial, densely flavescent-villous; leaves crowded, narrowly elliptic, entire, 3-nerved; peduncles becoming 2 cm. long; phyllaries densely villous at least above.

Stems several, prostrate or ascending, 6 cm. long or less, branched, slender, densely flavescent-villous; internodes at first very short, becoming 4 to 12 mm. long; leaves opposite, sessile, contracted into sheathing, scarious, glabrate or glabrescent, connate bases, obtusely callous-tipped, 3 to 5-plinerved, thickish, the lower up to 13 mm. long, 4 mm. wide, the middle and upper smaller, elliptic or elliptic-spatulate, 4 to 9 mm. long, 1.5 to 2.5 mm. wide, all densely flavescent-villous; heads subglobose, about 3.5 mm. high and thick, solitary, axillary and terminal, in anthesis subsessile, the peduncles in age becoming 2 cm. long, naked or bearing a leafy bract; phyllaries 6, about 2-seriate, appressed, the outermost one shorter, ovate, acutish, 2.8 mm. long, 1.5 mm. wide, 5-nerved, subherbaceous except for the slightly indurated base, densely villous and ciliate, the next 4 equal, broadly oval, obtuse, 3 mm. long, 2 mm. wide, with similar texture and pubescence, the inmost one oblong, 3 mm. long, 1.5 mm. wide, pilose along middle, scarious-margined, not ciliate, erose at tip; receptacular pales aristiform-subulate, about 2.5 mm. long, 0.2 mm. wide toward base, glabrous, 1-nerved; pistillate corollas 5, greenish yellow, densely long-villous on tube, sparsely so on limb, barely surpassing the involucre, 2.2 mm. long (tube 1.5 mm., lamina erect, cuneate, 3-toothed, 0.7 mm. long and about as wide); disk corollas 3 or 4, greenish yellow, densely long-villous on tube, glabrous above, 4 or 5-toothed, 1.8 mm. long (tube 0.7 mm., throat slightly broader, 0.7 mm., teeth deltoid, 0.4 mm.); ray achenes obovoid-oblong, 1.4 mm. long, plump, biconvex, slightly obcompressed, obscurely about 5-angled, glabrous, fuscous, epappose; disk achenes obovoid or elliptic-oblong, 1.2 to 1.5 mm. long, somewhat compressed, about 4-angled, multistriatulate, glabrous, epappose.

Type in the herbarium of the Field Museum, no. 534367, collected on grassy subalpine slopes at Chasqui, Dept. Huánuco, Peru, April 10, 1923, by J. F. Macbride (no. 3297). Duplicate in the U. S. National Herbarium, no. 1,191,439.

Readily distinguished by its dense pubescence and at length elongate peduncles. The genus, of which only one species has hitherto been described, has not previously been known south of Ecuador.

Montanoa lehmannii (Hieron.) Blake.

Eriocoma (*Montanoa*) *lehmannii* Hieron. Bot. Jahrb. Engler **19**: 54. 1894.

Related to *Montanoa quadrangularis* Schultz Bip. In *M. lehmannii* the leaves are densely prominulous-reticulate beneath, and the fruiting pales are provided at the retuse apex with a comparatively short and stout cusp about 0.5 mm. long. In *M. quadrangularis* the leaves are not densely prominulous-reticulate beneath, and the retuse fruiting pales have a slender, longer cusp, usually 1 to 1.5 mm. long. Specimens collected by M. T. Dawe (no. 700) in the Kew Herbarium show that the "arboloco" recently described by him[1] as an important source of timber and wood for billiard cues in Colombia is *M. lehmannii* and not *M. moritziana* Schultz Bip., as which his specimens were identified at Kew. The latter name, which has never been published with a description, belongs in the synonymy of *M. quadrangularis*.

[1] See RECORD, *Tropical Woods* **2**: 13. 1925.

A photograph and fragments of a specimen in the Kew Herbarium of *Lehmann* 7480. type collection of *E. lehmannii*, are now in the National Herbarium.

Viguiera leptodonta Blake, sp. nov.

Section *Diplostichis*; herb; stem loosely sordid-pilose; leaves opposite, ovate, slender-petioled, hirsute-pilose; heads small, several or numerous in terminal cymose panicles; involucre strigillose, 5 mm. high; achenes sparsely hispidulous; pappus of 2 awns and usually 4 narrow squamellae.

Stem subterete (3 to 4.5 mm. thick), 65 cm. high and more, probably lax or sprawling, branched, striate, white-pithy, loosely and rather densely pilose with dull white, several-celled, spreading hairs, glabrescent below; internodes 4 to 14.5 cm. long; leaves opposite essentially throughout; petioles slender, naked, densely hirsute-pilose, glabrescent, 1 to 2.5 cm. long; blades ovate, 6 to 11.5 cm. long, 2.5 to 6.5 cm. wide, acuminate, somewhat falcate, at base broadly rounded to cuneate-rounded, crenate-serrate practically throughout (teeth depressed, 3 to 4 per cm., the apiculate tips about 0.5 mm. long), membranous, above dark green, evenly but not densely hirsute with somewhat antrorse-curved white hairs with small tuberculate bases, beneath slightly lighter green, evenly but not densely hirsute-pilose on surface with spreading scarcely tuberculate-based hairs, densely so along the veins, tripli- or quintuplinerved essentially from base and loosely prominulose-reticulate; panicles terminating stem and branches, usually ternately divided, 3.5 to 7 cm. wide, about 15-headed, the principal branches subtended by somewhat reduced leaves, the other bracts filiform, 7 mm. long or less, the chief branches pubescent like the stem, the pedicels densely appressed-pubescent, 4 to 15 mm. long; heads 1.5 to 2 cm. wide; disk at first cylindric-oblong, becoming subglobose in fruit, in flower 8 to 10 mm. high, 5 to 7 mm. thick, in fruit about 1 cm. thick; involucre 2-seriate, equal or slightly unequal, 4.5 to 5 mm. high, the phyllaries 10, lanceolate or lance-ovate (1 to 1.5 mm. wide), sharply acuminate, subherbaceous, blackish green, densely strigillose, the outer with somewhat divergent tips; rays 8, yellow, neutral, pilose on tube and on nerves of back, the tube 1.5 mm. long, the lamina elliptic, 2-denticulate, 10 mm. long, 3 mm. wide, 7-nerved; disk flowers about 21, their corollas yellow, finely hispidulous throughout, short-hirsute on teeth, 6.5 mm. long (tube 1.3 mm., throat cylindric, 4.3 mm., teeth ovate, 0.9 mm.); pales acute, mucronulate, blackish green with scarious margins, hispidulous along middle, 7 mm. long; ray achenes (inane) trigonous, hispidulous, epappose; disk achenes obovate, strongly compressed, sparsely hispidulous especially above, 3 mm. long, 1.2 mm. wide; awns 2, slender, subequal, denticulate below, 4 mm. long; squamellae lanceolate, acute, lacerate, 1.5 to 2 mm. long, a pair at base of each awn and often 1 or 2 much smaller ones on one side between them.

Type in the U. S. National Herbarium, no. 1,230,823, collected along dry trail at Carapas, Sucre, Venezuela, alt. 1680 meters, in 1925, by G. H. H. Tate (no. 27). Additional specimen, with same data, collected under no. 26.

The only species of *Viguiera* hitherto known from Venezuela is *V. mucronata* Blake, to which and to *V. anomala* Blake, of Colombia, *V. leptodonta* is most closely related. In *V. mucronata* the stem hairs are all or mostly appressed, the achenes densely silky-pilose, the squamellae 4, broad and rounded, covering the whole apex of achene, and the disk corollas much shorter. In *V. anomala* the stem pubescence is denser and more sordid, the heads are narrower and fewer-flowered, and the achene is glabrous. The name of the new species refers to the slender apiculations of the leaf-teeth.

Viguiera pusilla astephana Blake, var. nov.

Achenes glabrous, epappose; otherwise as in the typical form.

Type in the herbarium of the Field Museum, no. 534812 (in part), collected in loose soil on slopes, Yanano, Dept. Huánuco, Peru, alt. about 1830 meters, May 13–16, 1923, by J. F. Macbride (no. 3750 in part). Duplicate in the U. S. National Herbarium, no. 1,191,464 (in part).

The sheet in the Field Museum bears 3 specimens, one with the pappus and pubescent achene of *Viguiera pusilla* (A. Gray) Blake, the others precisely similar except for the glabrous, epappose achenes. The National Herbarium sheet bears one specimen of each form. The plant is of particular interest from the fact that no epappose form has hitherto been known in the large section *Paradosa*, including nearly half the species of the genus.

Viguiera macbridei Blake, sp. nov.

Series *Aureae;* stems stout, very leafy, densely and canescently spreading-pilose; leaves alternate, narrowly lanceolate, acuminate, short-petioled, revolute-margined, bullate above, densely and canescently pilose-tomentose beneath; heads several or numerous, cymose-panicled, medium-sized; involucre graduate, 7 to 9 mm. high, hispid-pilose.

Herb, 1.3 to 1.6 m. high, several-stemmed; stems strict, subterete (4 to 8 mm. thick), striatulate, pithy, glabrate below, above densely pilose or hirsute-pilose with spreading or loosely reflexed white hairs 2 to 4 mm. long, with small tuberculate bases, and between them appressed- or ascending-pilose with shorter hairs; internodes mostly 3 to 10 mm. long; leaves alternate (except perhaps at extreme base); petioles stout, naked, 1 to 2 mm. long, densely hispid-pilose like the stem; blades narrow-lanceolate or linear-lanceolate, 5 to 6.5 cm. long, 5 to 13 mm. wide, acuminate, cuneate or rounded at base, subentire, strongly revolute-margined, subcoriaceous, above dark green, shining in age, harshly pilose-hispid with tuberculate-based antrorse hairs, beneath densely and canescently pilose-tomentose (the costa glabrate except for the persistent tuberculate hair-bases), triplinerved and with numerous pairs of lateral veins, these impressed above, mostly concealed beneath by the tomentum; heads about 2.8 cm. wide, 5 to 16 at apex of stem, terminal and on 1 to 4-headed axillary branches 5 to 15 cm. long, bearing reduced leaves, the pedicels or peduncles 4 cm. long or less; disk subglobose, 1 to 1.5 cm. high, 1 to 1.8 cm. thick; involucre 3 to 4-seriate, graduate, 7 to 9 mm. high, the phyllaries oblong-ovate to oblong (2 to 3 mm. wide), acute, appressed or with short spreading tips (glabrous inside), blackish green and subherbaceous with paler, more indurate base, 1-ribbed, densely hispid-pilose and ciliate with subappressed partly deciduous hairs with persistent tuberculate bases; receptacle rounded; rays about 8, golden yellow, neutral, pubescent on tube and nerves of back, the tube 1.3 mm. long, the lamina oval, 16 mm. long, 7.5 mm. wide, 3-denticulate, 12 or 13-nerved; disk flowers very numerous, their corollas yellow, pubescent chiefly on tube, base of throat, and back of teeth, 5.2 to 6.2 mm long (tube 1.2 to 1.8 mm., throat cylindric, 2.8 to 3.2 mm., teeth ovate, papillose-margined, 1 to 1.2 mm.); pales acute, carinate, blackish green and hispidulous above, 9 mm. long; ray achenes (inane) trigonous, with a pappus of about 6 lacerate squamellae up to 1.2 mm. long; disk achenes obovate-oblong, compressed, blackish, rather sparsely subappressed-pilose, 4 mm. long, 1.2 mm. wide; awns 2, slender, hispidulous, very unequal, 1.8 to 3 mm. long; squamellae of each side of achene connate into a lacerate scale 1 mm. long.

Type in the herbarium of the Field Museum, no. 535145, collected on steep rocky western grasslands, Huacachi, near Muña, Dept. Huánuco, Peru, alt. about 1980 meters, May 20–June 1, 1923, by J. F. Macbride (no. 4078). Duplicate in U. S. National Herbarium, no. 1,191,485.

A very distinct species of the Subseries *Euaureae*, related to *Viguiera sodiroi* (Hieron.) Blake and *V. mollis* Griseb., of Ecuador and Argentina respectively, but distinguished from both by its narrowly lanceolate leaves, as well as by other characters.

Helianthus acuminatus Blake, sp. nov.

Shrub; young branches densely griseous-pilose; leaves opposite, ovate, slender-petioled, acuminate, rounded at base, subentire, densely griseous-tomentose beneath; heads rather large; involucre about 13 mm. high, of oblong, acute or acuminate, cinerascent-puberulous and sparsely pilose phyllaries; disk corollas yellow or yellowish throughout.

Apparently tall; stem stout (up to 6 mm. thick), subterete, striatulate, glabrous or glabrate, with mostly opposite branches; young branches very densely pilose, almost tomentose, with mostly spreading whitish or griseous hairs with small tuberculate bases; internodes of main stem 6 to 10 cm. long, of the young leafy branches 1 to 2 cm.; leaves opposite practically throughout except in the inflorescence; petioles 0.8 to 1.8 cm. long, slender, densely pilose-subtomentose; blades ovate, 4 to 7 cm. long, 2.8 to 4.3 cm. wide, falcate-acuminate, at base broadly rounded, subtruncate, or subcordate, very shortly or not at all decurrent on the petiole, obscurely serrulate (teeth 4 to 5 per cm.) or subentire, firm, above green or blackish green, densely and rather softly short-pilose with antrorse, shining hairs with small glandular-tuberculate bases, beneath densely and softly griseous-tomentose, triplinerved essentially from base; heads about 3.8 cm. wide, axillary and terminal, 1 to 5 toward tips of stem and branches, on stout upwardly somewhat thickened spreading-pilose peduncles 1 to 14 cm. long; disk subglobose, 1.3 to 1.5 cm. high, 1.2 to 2 cm. thick; involucre about 4-seriate, graduate, 1.2 to 1.4 cm. high, the phyllaries oblong (2.8 to, in age, 5.5 mm. wide), acute or acuminate, blackish green, obscurely herbaceous above, the inner with loose tips, all densely and cinerascently appressed-puberulous and pilosulous, somewhat pilose above, glabrescent in age, about 3-nerved; rays 14 or more, yellow, neutral, pubescent on tube and nerves of back, the tube 2 mm. long, the lamina oblong-elliptic, 2-dentate, 2 cm. long, 6 mm. wide; disk corollas yellow throughout or greenish on the teeth, pilosulous chiefly toward base of tube, along nerves above, and on teeth, 7.5 mm. long (tube 1.5 mm., throat cylindric, 5.2 mm., teeth deltoid, 0.8 mm.); pales acute, usually mucronulate, pilosulous chiefly along the narrow keel above, 11 mm. long; achenes oblong-obovate, compressed, blackish, glabrous, 3.8 mm. long, 1.5 mm. wide; awns 2, lanceolate, hispidulous-ciliolate, caducous, 3 mm. long; rays achenes (inane) with 2 less caducous, lacerate squamellae 1 mm. long.

Type in the herbarium of the Field Museum, no. 518863, collected on open, moist, rocky slope at Tomaiquichua, a pueblo three miles below Ambo, Dept. Huánuco, Peru, alt. about 2590 meters, September 19, 1922, by J. F. Macbride and W. Featherstone (no. 2429). Duplicate in U. S. National Herbarium, no. 1,198,894.

Allied to *Helianthus grandiceps* Blake, of Ecuador, which has alternate leaves with cuneate or rounded-cuneate base, more definitely toothed, and with the lateral nerves arising distinctly above the base, and longer involucre;

also to *H. jelskii* Hieron., of Peru, in which the leaves are much thicker, and densely ochroleucous-lanate-tomentose and lacunose-reticulate beneath.

Helianthus discolor Blake, sp. nov.

Shrub; branches appressed-pilose, glabrate or glabrescent; leaves opposite below, alternate above, often with axillary fascicles, linear-lanceolate or linear, 3.8 cm. long or less, greenish and strigose above, beneath white-tomentose; heads solitary at tips of stem and branches, medium-sized; involucre 9 mm. high, of lanceolate or lance-oblong, cinereously appressed-pubescent phyllaries, only their extreme tips loose; disk corollas yellow, with fuscescent teeth.

Stems in clumps from a caudex, 40 cm. long and more, slender (2.5 mm. thick or less), alternate-branched, gray-barked, glabrate; branches thinly appressed-pilose, somewhat glandular, and toward the nodes often tuberculate-hispid; petioles pilose, 1.5 mm. long or less; blades of the principal leaves 2.3 to 3.8 cm. long, 4 to 6 mm. wide, usually acuminate to an obtuse apex, cuneate at base, somewhat falçate, entire or subentire, revolute-margined, subcoriaceous, above dull green, rather densely strigose to sparsely hispidulous with glandular-tuberculate-based hairs, somewhat glabrescent, beneath densely and loosely white-tomentose, triplinerved near base and feather-veined, the veins impressed above, evident beneath through the tomentum in age; leaves of the fascicles linear, about 1.5 cm. long, 1.5 mm. wide, or smaller; peduncles terminating stem and branches, 3 to 7 cm. long, naked or few-bracted, sordid-pilose and sparsely hispid below the heads; heads 3.5 cm. wide or less; disk hemispheric, 9 to (fruit) 14 mm. high, 1 to (fruit) 2 cm. thick (as pressed); involucre 3 to 4-seriate, graduate, 8 to 9 mm. high, the phyllaries lanceolate or oblong (outer) to oblong-lanceolate (the inner 1.5 to 2.5 mm. wide), appressed or (especially the outer) with spreading tips, the outer subherbaceous essentially throughout, densely appressed-pilose and somewhat hirsute, the others indurate and blackish below and there nearly glabrous except for the hirsute-ciliate margin, with shorter or longer obtuse to acutish herbaceous tips, these densely appressed-pilose, more or less ciliate, and somewhat glandular; rays about 9, yellow, neutral, pubescent on tube and on nerves of back, glandular between them, the tube 1 mm. long, the lamina oblong, 2-toothed, about 10-nerved, 15 mm. long, 5 mm. wide; disk corollas puberulous on lower part of tube, on nerves above, and on teeth, 7.3 mm. long (tube 1.2 mm., throat cylindric, 5 mm., teeth ovate, 1.1 mm.); pales acuminate, often mucronulate, blackish above along costa, hispidulous above along keel and ciliolate, about 9 mm. long; achenes oblong-obovate, compressed, glabrous, 3.3 mm. long, 1.5 mm. wide; awns 2, linear-subulate, hispidulous, caducous, about 2 mm. long.

Type in the herbarium of the Field Museum, no. 518724, collected on eastern side of canyon at Llata, Dept. Huánuco, Peru, alt. about 2135 meters, August 21, 1922, by J. F. Macbride and W. Featherstone (no. 2240). Duplicate in the U. S. National Herbarium, no. 1,198,892.

Allied to *Helianthus microphyllus* H. B. K. and *H. subniveus* Blake (*H. niveus* Hieron., not Brandeg.). In the former the involucre is only 5 mm. high, with oblong, apically tomentose phyllaries; in the latter it is 1 cm. long, and densely niveo-tomentose.

Helianthus senex Blake, sp. nov.

Shrub; branches canescently long-villous, glabrescent; leaves mostly

opposite, broadly ovate, serrulate, petioled, cinereous-pilose above, densely white-tomentose beneath; heads medium-sized, solitary on axillary and terminal peduncles; involucre 8 mm. high, graduate, the phyllaries oblong, obtuse, canescent-tomentose especially above; disk corollas yellow throughout.

Shrub 1 meter high, growing in clumps; stem stout (4 to 7 mm. thick), with opposite or alternate branches, terete, in age glabrate and conspicuously lenticellate; branches very densely long-villous with loosely spreading or reflexed white hairs 2 to 3 mm. long and with slightly enlarged bases, glabrescent, striatulate; internodes mostly 0.5 to 2.5 cm. long; leaves chiefly opposite, alternate above on the flowering branches; petioles stout, 5 to 15 mm. long, unmargined, densely pilose-tomentose; blades ovate, the larger 5 to 6.5 cm. long, 3 to 4 cm. wide, acute, broadly rounded at base and very shortly decurrent on the petiole, serrulate or crenate-serrulate above the entire base (teeth about 4 per cm.), thick-herbaceous, above densely cinereous-pilose with mostly spreading hairs with small glandular-tuberculate bases, beneath very densely and softly white-tomentose, triplinerved from near the base, the principal veins at first impressed, later prominulous above, beneath at length evident beneath the tomentum; branch leaves often smaller, yellowish above; peduncles axillary and terminal, 2 to 5 toward tips of branches, normally 1-headed, spreading-pilose, glabrescent, naked or few-bracted, 2 to 8 cm. long; heads 2 cm. wide; disk subglobose, 1 to 1.3 cm. high, 8 to 15 mm. thick; involucre 3 to 4-seriate, graduate, 7 to 8 mm. high, the phyllaries appressed or with very short spreading tips, oblong (1.3 to 2 mm. wide) or the outer oblong-ovate, obtuse, with indurated, blackish, pale-margined, glabrate (in the inner nearly glabrous) base and shorter, densely pilose-tomentose, herbaceous apex; rays about 8, small, yellow, neutral, pilose on tube and on nerves of back, the tube 1.5 mm. long, the lamina elliptic-oblong, 5 to 10 mm. long, 2 to 4 mm. wide, 3 or 4-denticulate, 9-nerved, sometimes bearing at base 2 appendages suggesting abortive stamens; disk corollas sparsely hispidulous chiefly on nerves above and on teeth, 6.3 mm. long (tube 1.3 mm., throat cylindric, 4.5 mm., teeth deltoid, 0.5 mm.); pales acute or acutish, callous-apiculate, not keeled, pilose and ciliate above, 11 mm. long or less; achenes oblong, compressed, blackish, glabrous, 3.5 mm. long, 1.3 mm. wide; awns 2, linear-lanceolate, hispidulous-serrulate, caducous, 3 mm. long.

Type in the herbarium of the Field Museum, no. 518,077, collected on canyon slope at Mito, Dept. Huánuco, Peru, alt. about 2745 meters, July 8–22, 1922, by J. F. Macbride and W. Featherstone (no. 1572). Duplicate in the U. S. National Herbarium, no. 1,198,884.

Nearest *Helianthus imbaburensis* Hieron., of Ecuador, which has alternate, acuminate, entire leaves and shorter sub-2-seriate involucre of more densely and uniformly pilose-tomentose phyllaries.

Helianthus viridior Blake, sp. nov.

Shrub, much branched, very leafy; branches appressed-pilose, glabrate; leaves chiefly alternate, lanceolate, short-petioled, subentire, appressed-subsericeous when young, soon glabrescent and green on both sides; heads medium-sized, solitary; involucre 1 cm. high, of lanceolate or lance-ovate acuminate phyllaries, densely pilose above; disk corollas with fuscous teeth.

Stem terete (5 mm. thick), gray-barked, lenticellate, glabrous, apparently procumbent, 30 cm. long and more, sending out numerous mostly simple or subsimple alternate ascending branches nearly or quite as long; young

branches warty, not densely appressed-pilose, the older gray-barked, glabrate or glabrescent; internodes on the older portions mostly 1 to 5 mm. long, on the younger mostly 1 to 2.5 cm.; leaves opposite at base of branches, alternate above; petioles slender, naked, appressed- or erectish-pilose, 3 to 8 mm. long; blades lanceolate, 3 to 4.3 cm. long, 5 to 13 mm. wide, acuminate to acutish, callous-apiculate, cuneate at base, entire or obscurely serrulate mostly above the middle, rather thin, triplinerved above the base, scarcely reticulate, above at first canescently subsericeous-pilose with appressed hairs, soon glabrescent, green, and evenly appressed- or antrorse-pilose (the hairs with scarcely enlarged glandular bases), beneath at first densely and canescently appressed-silky-pilose, soon green and loosely antrorse-pilose, usually narrowly revolute on margin; peduncles solitary, terminating stem and branches, 1-headed, appressed-pilose, naked or few-bracteate, 3.5 to 5 cm. long; heads about 3 cm. wide; disk subglobose, 1 to 1.3 cm. high and thick; involucre 3 to 4-seriate, graduate, 8 to 11 mm. high, the phyllaries lanceolate or linear-lanceolate (outer) to lance-ovate, mostly acuminate, with short callous blackish tips, rather densely and loosely pilose on their exposed portions and ciliate, appressed or with rather loose tips, the outermost subherbaceous and blackish green throughout, the others pale and multivittate below, with mostly longer blackish green tips; rays about 9, neutral, yellow, linear-elliptic, 9 to 12-nerved, 2 or 3-denticulate, pilose on tube and sparsely so on principal nerves of back, the tube 1.5 mm. long, the lamina about 15 mm. long, 3 to 4 mm. wide; disk corollas numerous, yellow with fuscous teeth, sparsely pilosulous on tube and back of teeth, 6 mm. long (tube 1 mm., throat cylindric, 4.3 mm., teeth triangular, acute, 0.7 mm.) pales acuminate, blackish above, sparsely pilose chiefly above, somewhat glandular on the sides, about 8 mm. long; infertile ovaries of the ray with a pappus of 2 or 3 lacerate squamellae 0.5 mm. long; disk achenes oblong, compressed, blackish, glabrous, 4 mm. long, 1.5 mm. wide; pappus of 2 caducous, lanceolate-acuminate, hispidulous-ciliolate awns 3 mm. long.

Type in the herbarium of the Field Museum, no. 517591, collected in crevices of a vertical limestone cliff at Tarma, Dept. Junin, Peru, alt. about 3965 meters, June 1–6, 1922, by J. F. Macbride and W. Featherstone (no. 1070). Duplicate in U. S. National Herbarium, no. 1,198,869.

Readily distinguished from the other Andean species by its lanceolate, glabrescent leaves.

Perymenium featherstonei Blake, sp. nov.

Shrub; branches strigillose; leaves lance-ovate, slender-petioled, acuminate, rounded at base, crenate-serrate, bullate and green above, densely griseous-tomentose beneath; heads small, slender-peduncled, in small cymes; involucre 5 mm. high, of broadly ovate, obtuse, strigillose phyllaries.

"Tree-shrub, 1.3 to 2.3 m. high, rather open but very erect," with opposite branches; stem subterete (3 to 6 mm. thick above), striatulate, lenticellate, glabrate, brownish or dark gray; internodes 1.5 to 6.5 cm. long; leaves opposite; petioles slender, naked, sulcate above, strigillose, appressed-pilose above, 5 to 12 mm. long; blades 5 to 8 cm. long, 1.5 to 3 cm. wide, crenate-serrate from above the short entire base to apex (teeth rounded, subequal, 4 to 5 per cm.), narrowly revolute-margined, subcoriaceous, above dull green, densely and harshly tuberculate-hispidulous with subappressed hairs, strongly bullate, beneath densely and rather softly griseously or cinereously pilose-tomentose except on the 3 chief nerves (these strigose), triplinerved 2 to 4 mm.

above base and reticulate, the veins and veinlets impressed above, the chief ones prominent beneath, the others mostly concealed by the tomentum; heads in cymes of 2 to 5 at tips of branches, subtended by reduced leaves, the pedicels angulate, strigillose, usually 1.5 to 4.5 cm. long; disk (in old fruit) subglobose, 6 to 7 mm. high, 7 to 9 mm. thick; involucre 3 to 4-seriate, graduate, 4 to 5.5 mm. high, appressed, the phyllaries broadly ovate or orbicular-ovate, obtuse, obscurely and shortly subherbaceous at apex, otherwise pale and indurated, strigillose and finely ciliolate; rays not seen; disk corollas (imperfect) about 3.2 mm. long; pales acutish to acuminate, narrow, strongly 1-ribbed, minutely hispidulous on keel, about 6 mm. long; ray achenes trigonous, hispidulous on angles and at apex, their pappus of 20 unequal, hispidulous, deciduous awns 1 to 1.8 mm. long; disk achenes obovoid-oblong, 2.5 to 3.2 mm. long, 1.5 mm. wide, biconvex, biauriculate at apex, narrowly whitish-margined, finely hispidulous especially on margin and at apex, fuscous, finely papillate, their pappus of 2 slender hispidulous awns 2.5 to 2.8 mm. long, on the angles, and about 12 similar shorter awns 1 mm. long or less, all deciduous.

Type in the herbarium of the Field Museum, no. 517839, collected in river canyon at Cabello, a hacienda 14.5 km. above Huertas, Dept. Junin, Peru, alt. 2440 meters, June 25, 1922, by J. F. Macbride and W. Featherstone (no. 1329). Duplicate in the U. S. National Herbarium, no. 1,198,875.

Allied to *Perymenium serratum* Blake, of the Province of Chachapoyas, which has a much larger involucre, 9 to 10 mm. high.

Pappobolus cinerascens Blake, sp. nov.

Branches slender, cinerascent-pilosulous and sparsely pilose; leaves lance-ovate, subentire, green and rough above, densely cinereous-pilose beneath; heads 2 or 3, terminal, medium-sized; involucre cinerascent-puberulous and somewhat pilose, graduate, of lance-ovate acuminate phyllaries with reflexed herbaceous tips.

Herb (?); branches slender (2 mm. thick), simple, subterete, striatulate, pithy, densely cinerascent-pilosulous with chiefly spreading or reflexed hairs and sparsely spreading-pilose; internodes 4.5 to 7 cm. long; leaves opposite throughout, or those subtending the peduncles alternate; petioles naked, densely spreading-pilosulous and long-pilose, 4 to 13 mm. long; blades lance-ovate or lanceolate, 6 to 8 cm. long, 1.7 to 2.5 cm. wide, acuminate, falcate, at base cuneate or rounded, entire or obscurely and remotely serrulate, very narrowly revolute-margined, above blackish green, densely and harshly hirsutulous and hirsute with curved hairs with persistent tuberculate bases, maculate in age, beneath densely and softly subtomentose-pilose with antrorse hairs, triplinerved 1 to 2 mm. above base, the chief veins usually impressed above, prominulous beneath; heads 4 to 4.5 cm. wide, in terminal cymes of 2 or 3, the peduncles slender, naked or with a single bract, pubescent like the stem, 2 to 8.5 cm. long; disk depressed-subglobose, 1.2 cm. high, 1.5 to 2.3 cm. wide (as pressed); involucre 4 to 5-seriate, graduate, 7 to 9 mm. high, the phyllaries lance-ovate or lanceolate (1.5 to 2.5 mm. wide), with blackish green, ribbed and vittate base and longer to shorter, reflexed, acuminate, somewhat involute, callous-tipped, herbaceous apex, densely cinereous-puberulous (inside and outside) on their exposed surface, tuberculate-hispidulous above, more or less pilose dorsally above, ciliolate; rays 18 or more, yellow, neutral, pilosulous on tube and nerves of back, the tube slender, 2 mm. long, the lamina elliptic, 2.4 cm. long, 6 mm. wide, 9-

nerved, 2-dentate; disk flowers very numerous, their corollas yellow, fuscescent on teeth, puberulous on nerves of throat and on teeth, 6.7 mm. long (tube 1.5 mm., throat slender-funnelform, 4.2 mm., teeth ovate, 1 mm.); ray achenes (inane) with a caducous pappus of about 14 linear-lanceolate spinulose-serrulate unequal paleaceous awns 1.2 to 1.8 mm. long; disk achenes obovate-oblong, very strongly compressed, fuscous, glabrous, striatulate, 4 mm. long, 1.5 mm. wide, their pappus of about 16 caducous awns like those of the ray achenes, 1.8 to 2.8 mm. long, those on the angles the longest.

Type in the Kew Herbarium, collected in the Province of Chachapoyas, Peru, in 1836, by A. Mathews. Photograph and fragment of type in U. S. National Herbarium; duplicate in British Museum.

Allied to *Pappobolus mollicomus* Blake, also from Chachapoyas, with duplicate types of which (in Kew Herbarium and British Museum) it has been possible to compare it. In *P. mollicomus* the pubescence of stem and peduncles is much longer, being composed of long, spreading, tuberculate-based hairs, and the phyllaries are broader (3 to 4.5 mm. wide) and densely canescent-pilose, with longer spreading herbaceous tips. *Pappobolus macranthus* Blake, the type of the genus, is distinguished from the two other species by its usually broader, definitely serrate leaves, which are griseous- rather than canescent- or cinereous-pubescent beneath. It was described from Muña, Peru (wrongly "Bolivia" in the original description), and has been collected at Mito, Peru, 1922, by Macbride and Featherstone (no. 1384, a smaller-headed form than the original) and at Chaglia, Peru, 1923, by Macbride (no. 3646). All three localities are in the Department of Huánuco.

Oyedaea maculata Blake, sp. nov.

Shrub; branches densely scabrous-hispidulous; leaves oval or ovate-oval, acute, rounded at base, serrulate, very rough on both sides, triplinerved, short-petioled; heads medium-sized, 1 or 2 at tips of branches and in upper axils, short-peduncled; involucre 9 mm. high, of oblong, acuminate, herbaceous-tipped, scarcely spreading phyllaries.

Stem stout (5 mm. thick), striate, brownish, densely incurved- or appressed-hispidulous with tuberculate-based persistent hairs; internodes 5 to 20 mm. long; leaves opposite; petioles broad, densely tuberculate-hispidulous, 2 to 4 mm. long; blades 3.5 to 5 cm. long, 1.7 to 2.7 cm. wide, sparsely serrulate above the middle (teeth 3 to 5 pairs, 3 to 6 mm. apart), narrowly revolute-margined, firm and subcoriaceous, above brownish green, somewhat shining, evenly hispidulous with curved hairs with tuberculate or glandular-tuberculate persistent bases, beneath duller brownish green, evenly but not densely short-hispid on surface with spreading or slightly incurved hairs with small tuberculate bases, antrorse-hispid along the nerves, rather definitely triplinerved within 3 to 6 mm. of base (the lateral pair reaching slightly above middle of leaf) and with 6 to 8 other pairs of principal lateral nerves of which 1 or 2 are conspicuously stronger than the others, the nerves and veins impressed above, prominent or prominulous beneath; peduncles 1-headed, solitary, terminal and in the upper axils, pubescent like the stem, 6 to 12 mm. long; heads 3.8 cm. wide or less; disk hemispheric, 1 to 1.3 cm. high, 1.2 to 1.5 cm. thick (as pressed); involucre 8 to 10 mm. high, 3-seriate, slightly or scarcely graduate, the phyllaries oblong (2 to 2.5 mm. wide), erect or with slightly spreading tips, acuminate, callous-tipped, the outermost herbaceous throughout, rather sparsely tuberculate and short-hispid, 1-nerved, the others with pale, indurate, more or less hispidulous-ciliate, otherwise nearly glabrous

base, and subequal, glandular-tuberculate, sparsely hispidulous and hispid herbaceous tips; rays about 11, yellow, neutral, hispidulous on tube and back, the tube 2 mm. long, the lamina oblong-elliptic, bidentate, up to 2 cm. long, 5 mm. wide, about 11-nerved; disk corollas yellow, essentially glabrous except for the finely hispidulous teeth, 7 mm. long (tube 2 mm., throat cylindric-funnelform, 4.2 mm., teeth ovate, 0.8 mm.); pales acuminate, keeled, hispidulous on the slightly greenish apex, about 9 mm. long; disk achenes obovate-oblong, compressed, biconvex, 4.5 mm. long, 2.2 mm. wide, fuscous, 2-winged (wings thick, about 0.3 mm. wide, hispidulous on margin), very sparsely strigillose; awns 2, very unequal, hispidulous, 1.8 to 4 mm. long; squamellae acute, unequal, lacerate, united below, 0.8 mm. long or less.

Type in the U. S. National Herbarium, no. 1,230,911, collected on the subparamo, Cerro de Turumiquire, Sucre, Venezuela, alt. 2975 meters, in 1925, by G. H. H. Tate (no. 232). Additional specimen, with the same data, collected under no. 233.

Related to *Oyedaea wedelioides* (Klatt) Blake, of Peru, and *O. jahnii* Blake, of the Province of Mérida, Venezuela. In the former the leaves are decidedly larger and borne on petioles 4 to 15 mm. long, the heads are several or numerous and cymose-panicled, and the phyllaries have spreading tips. In the latter the leaves are ovate or lance-ovate and much larger, and the heads are larger, solitary, and longer-peduncled.

Verbesina tatei Blake, sp. nov.

Section *Saubinetia;* stem stout, pithy, leafy, densely lanate-tomentose; leaves alternate, large, elliptic-oval, acute or acuminate at each end, repand-serrulate, stout-petioled, rough above, densely sordid-pilose beneath; heads medium-sized, yellow, radiate, many-flowered, numerous in a rounded terminal panicle; involucre about 8 mm. high, of oblong, obtuse, sordid-pilosulous phyllaries; rays about 5 mm. long.

Shrub or large herb; stem subterete, 8 mm. thick above, glabrate and yellowish brown below, densely lanate-tomentose above with dirty-white hairs; internodes about 1 cm. long; petioles 2 to 3 mm. thick, narrowly grooved beneath, densely lanate-tomentose, margined above the decurrent leaf base, the naked portion 2.5 to 3.5 cm. long; blades 12 to 20.5 cm. long, 4.5 to 8.5 cm. wide, thick-pergamentaceous, repand-serrulate above the entire cuneate base (teeth small, obtuse, 2 to 5 mm. apart), above dark green, evenly hirsutulous on surface with antrorse-curved hairs with small glandular-tuberculate persistent bases, hirsute-pilose along costa and chief veins, beneath brownish green, densely and rather softly ochroleucous-pilose on surface with curved hairs, very densely so on chief veins, featherveined, the chief lateral veins about 11 pairs, like the stout costa prominent beneath, the veinlets prominulous beneath, mostly impressed above; heads 1.8 cm. wide, about 32, on axillary and terminal peduncles, in a rounded panicle 11 cm. wide, about equaled by the leaves, the bracts small, the pedicels stout, 1.5 to 3 cm. long, densely sordid-pilose; disk subglobose, 1 cm. high, 1.3 cm. thick; involucre 3 to 4-seriate, graduate, 7 to 8 mm. high, appressed, the phyllaries oblong or the outermost ovate-oblong (1.5 to 3 mm. wide), obtuse, dark green, subherbaceous with (especially the inner) narrow pale margins, 1-nerved, sordid-pilosulous especially along costa and margin; rays 9 to 12, slightly exceeding disk, yellow, pistillate and bearing imperfect anthers, pilose on tube and nerves of back, 8.5 mm. long (including tube), 3 to 4 mm. wide; disk flowers about 75, their corollas yellow, pilose on tube and teeth

with several-celled acuminate hairs, glabrous on throat, 6 mm. long (tube 1.3 mm., throat subcylindric, 3.7 mm., teeth ovate, 1 mm.); pales pilose on the narrow keel and margin and on the yellowish, somewhat spreading or recurved, subscarious obtuse apex, about 7.5 mm. long; immature disk achenes obovate, compressed, scarcely winged, ciliate, sparsely pubescent above, 2.8 mm. long; awns, 2, subequal, stout, trigonous, hispidulous on keel, 4.5 mm. long.

Type in the U. S. National Herbarium, no. 1,230,946, collected on an exposed ridge, Cerro de Turumiquire, Sucre, Venezuela, alt. 1830 meters, in 1925, by G. H. H. Tate (no. 350).

In pubescence, foliage, and inflorescence this species is strikingly like *Verbesina crassiramea* Blake of Colombia, a member of the Section *Lipactinia* with discoid, 5 to 14-flowered heads. Its closest ally, however, is the long-doubtful *V. humboldtii* Spreng. (*V. helianthoides* H. B. K., not Michx.) of Colombia. In the latter the stem is ascending-pilose to spreading-pilosulous, the internodes are longer, the petioles margined nearly to base, the leaves less densely and softly pubescent beneath, the heads much larger, the rays longer and apparently white, the phyllaries of the somewhat longer involucre distinctly broader, and the pales essentially glabrous (except for the more or less ciliate margin) on the thin acute or acuminate tip.

Verbesina humboldtii Spreng. was left among the doubtful species by Robinson and Greenman in their revision of the genus. It was described (as *V. helianthoides* H. B. K.) from "Regno Quitensi?," and is represented in the Paris Herbarium by at least two sheets of the original material. Hieronymus at first[3] referred to it *Lehmann* 7481 from Colombia, but later[4] described this as a new species, *V. lehmannii*, distinguishing it from *V. humboldtii* by several supposed differential characters derived from the original description of the latter. During the summer of 1925 I examined the type material of *V. helianthoides* H. B. K. at Paris and a specimen of *Lehmann* 7481 at Kew, and, through the courtesy of the curators of these herbaria, obtained photographs and small fragments of both specimens. Study of these shows that Hieronymus' species can not be maintained as distinct from *V. humboldtii*. *Triana* 1381, from Bogotá, alt. 2,300 meters, which I have on loan from the British Museum and the Kew Herbarium, belongs to the same species. The position of *V. humboldtii* is somewhat difficult to settle satisfactorily. So far as the size of the rays indicates, it might be placed as a small-flowered *Verbesinaria* (as was done by Hieronymus) or a large-flowered *Saubinetia* (in the Paris specimens I recorded the rays as only 7 mm. long), but their white color would refer it rather to *Ochractinia* in Robinson and Greenman's treatment. One or two species of *Saubinetia* (particularly *V. semidecurrens* Kuntze, of which *V. soratae* Schultz Bip. is a synonym) are now known to have white rays, however, and the best position for *V. humboldtii* is probably in this group among the species numbered 68 to 79 in Robinson and Greenman's treatment, from all of which it is distinct.

In three heads of *Verbesina tatei* examined the rays were all intermediate in form and structure between normal rays and disk corollas, being hermaphrodite and imperfectly ligulate. The short proper tube, at the apex of which are inserted the very unequal, nearly free, and non-polliniferous stamens, is continued into a funnelform throat shorter than the proper lamina. The latter is equally or unequally 3-toothed, and sometimes bears a large

[3] Bot. Jahrb. ENGLER 19: 54. 1894.
[4] Bot. Jahrb. ENGLER 28: 612. 1901.

lateral lobe and a much smaller one, or the other two segments of the corolla are represented by two small and unsymetrically placed teeth on one side of the apex of the throat. The style branches bear elongate hispidulous sterile appendages. Although the condition is doubtless abnormal, and not characteristic of the species, it is of interest as showing how easy is the transition from the tubular 5-toothed disk corolla, the theoretical type of the asteraceous corolla, to the 3-toothed pistillate ligule.

Verbesina oligactis Blake, sp. nov.

Section *Ochractinia;* tall; stem wingless, densely spreading-pilose with yellowish hairs; leaves alternate, large, oblong-elliptic, acuminate at each end, obscurely denticulate, tuberculate-pilosulous above, densely short-pilose beneath especially along the veins, short-petioled; heads small, very numerous, white, in a large terminal panicle, sessile or short-pedicelled; rays 1 or 2, disk flowers 11 to 13.

Tall herb (?); stem stout (6 mm. thick above), striate-angulate, pithy, densely spreading-pilose with yellowish-white hairs about 1 mm. long; internodes about 1 cm. long; petioles stout, densely pubescent like the stem, the unmargined portion 3 to 5 mm. long; blades 20 to 25 cm. long, 4 to 7 cm. wide, long-cuneate at base, remotely denticulate with small blunt callous teeth (0.3 mm. high, 3 to 8 mm. apart), papery, above dull green, evenly antrorse-pilosulous with yellowish-white hairs with glandular-tuberculate persistent bases, densely short-pilose along costa, beneath densely griseous- or flavescent-pilose along the chief veins with spreading several-celled hairs, less densely so on all the veins and veinlets, featherveined, the chief lateral veins 10 to 12 pairs, rather prominent beneath, the chief veinlets prominulous; panicle terminal, flattish, very many-headed, 20 cm. wide, pubescent like the stem, the bracts small (mostly 3.5 cm. long or less), definitely serrulate with dark callous teeth, the pedicels usually 2 mm. long or less, sometimes up to 6 mm.; heads 6 to 8 mm. wide; disk obovoid, 4.5 to 6 mm. high, 3 to 4.5 mm. thick; involucre 2-seriate, unequal, 3 mm. high, the phyllaries few, lance-oblong or oblong (about 1 mm. wide), obtuse, appressed, thickened and subherbaceous at base, with longer, thinner, submembranous, pale tip, loosely and rather sparsely pilosulous and ciliolate; rays 1 or 2, white, pistillate, the tube pilose, 1.5 mm. long, the lamina oblong, 4.8 mm. long, 2 mm. wide, nearly glabrous, 3-denticulate, 7-nerved; disk flowers 11 to 13, their corollas white, blackish green below the teeth, pilose on tube and throat, glabrous on teeth, 4 mm. long (tube 1 mm., throat cylindric-funnelform, 2.5 mm., teeth ovate, papillose-margined, 0.5 mm.); pales submembranous, blackish green with subscarious margins, pilosulous, ciliate above, subtruncate or with short blunt erect or slightly spreading glabrous apiculation, about 5 mm. long; disk achenes (immature) ciliate, pilose especially above, narrowly winged, 2.8 mm. long; awns 2, unequal, hispidulous, 2.2 to 2.7 mm. long.

Type in the Kew Herbarium, collected at San Miguel, Sierra Nevada of Santa Marta, Colombia, November 1844, by William Purdie. Photograph and fragments in U. S. National Herbarium.

A member of the *Verbesina punctata* group, nearest *V. synethes* Blake, also a Colombian species, which has thicker heads, containing 8 rays and about 29 disk flowers, borne on pedicels 7 to 14 mm. long. Similar also to *V. callacatensis* Hieron., of the Section *Lipactinia*, in which the heads sometimes bear as many as 3 very small rays. In that species the petioles are always auriculate at base, the heads are considerably larger, and the involucre is densely pubescent.

RADIOTELEGRAPHY.—*Preliminary note on proposed changes in the constants of the Austin-Cohen transmission formula.*[1] L. W. AUSTIN. Laboratory for special Radio Transmission Research. (Conducted jointly by the Bureau of Standards and the American Section of the International Union of Scientific Radio Telegraphy.)

It has been known for a number of years that the Austin-Cohen transmission formula, while satisfactory for moderate distances and wave lengths, gives values at 6000 km which are only about one-half of those observed, and that at 12000 km the ratio appears to be about one to four.

Our original formula[2] for daylight signals over salt water of 1910–1914, was written

$$E = 120\,\pi\,\frac{hI}{\lambda d}\sqrt{\frac{\theta}{\sin\theta}}\,e^{-u}\ \text{(volts km. amp.)}$$

where $u = \dfrac{0.0015d}{\lambda^{0.5}}$. The constants in u were determined empirically from shunted telephone observations for distances up to 2000 km and frequencies between 1000 kc (λ = 300 m) and 80 kc (λ = 3750 m).

Naturally I have been desirous of bringing the formula into better agreement with the observations. Acting on the advice of some of my European colleagues in the URSI, I have given up the idea of altering the Hertzian portion of the formula since this is the portion that rests on a theoretical basis, and have given attention only to possible changes in the values of the constants of the exponential term. These can easily be arranged so as to give excellent agreement for limited ranges of wave length and distance, but in order to give the formula a general character, it should be at least approximately accurate for all frequencies between f = 1000 *kc* (λ = 300 m) and 12 *kc* (λ = 25000 m).

During recent years a very considerable amount of experimental data on signal field strength has been collected. Long series of transatlantic observations have been taken by the American Telephone & Telegraph Company, The Radio Corporation of America, The Marconi

[1] Published by Permission of the Director of the Bureau of Standards of the U. S. Department of Commerce.

[2] Bureau of Standards Bulletin VII; 315. 1911. Reprint 159; and XI; 69. 1914. Reprint 226.

Company, the French Army at Meudon, near Paris, and the Bureau of Standards. The Marconi Company has also collected a vast amount of experimental reception data from various transmitting stations during the voyages of the S. S. Dorset from England to New Zealand (February and March, 1922) by way of the Panama Canal, and of the S. S. Boonah from Australia to England (June, July, August, 1923) through the Suez Canal. In addition, the Indian Post Office made field intensity measurements at Karachi, India, on several of the European high-power stations from November, 1921, to January, 1923.

All this material now makes it possible to determine the variations of field intensity with varying wave length and distance with some degree of certainty. The relative value of the different series of observations of course differs widely. Those in which the same stations are observed regularly over one or more years are naturally the most valuable. Those which have been taken during the voyages of ships, while important, may show large variations during different parts of the voyage, since in general only one observation is taken at any given distance from the transmitting station, and the results can at best represent the conditions during only limited portions of the year.

The use of much of the experimental material for deriving a formula which must by definition hold for an all water path is complicated by the fact that in most cases of long distance transmission the waves pass for a considerable distance over land. For example, the shortest great circle distance between Nauen, Germany, and Washington is roughly twenty-five per cent land, Rocky Point to London twenty per cent, Buenos Aires to Washington more than fifty per cent, while from Karachi, India, to the European transmitting stations nearly the whole path is over land.

The question of the relative land and water attenuation in radio transmission is not at all settled. It is generally agreed that for wave lengths below 5000 m, land attentuation is much greater than that over water, and it seems probable that there is considerable, though decreasing, land effect from 5000 m up to at least 15000 m. The amount of this effect naturally depends upon the character of the land traversed, and especially on conditions in the neighborhood of the transmitting and receiving stations. Observations at Washington covering more than two years indicate that signals from Bolinas, California, near San Francisco $f = 22.9$ kc ($\lambda = 13100$ m) have practically the same attenuation as over water, if the reported effective

height of the station is correct. On the other hand, a much more limited number of observations in Washington on San Diego, and in San Diego on the east coast stations indicate nearly twice the water attenuation. This may be due to local conditions near San Diego as this has always been thought by operators to be less favorable for radio work than San Francisco.

Notwithstanding these uncertainties, it has seemed worth while to make use of the accumulated data for obtaining at least tentative constants for a new formula. Up to the present a value of $u = \frac{0.0014d}{\lambda^{0.6}}$ seems to give fairly satisfactory results. This may be slightly varied as more and better observational data are obtained. Table 1

TABLE 1.—RATIO OF NEW AND OLD VALUES OF e^{-u}

λ km	d km					
	500	1000	2000	4000	6000	12000
0.3	0.93	0.86	0.72			
0.5	1.00	1.00	1.00			
1.0	1.05	1.11	1.22			
2.0	1.07	1.14	1.31			
3.0	1.07	1.15	1.33	1.77		
5.0			1.32	1.72	2.25	
10.0			1.31	1.62	2.09	4.40
16.0				1.55	1.94	3.75
24.0					1.80	3.25

gives the ratio of the new to the old values of e^{-u} at various wave lengths and distances, and Table 2 shows a collection of observed intensity values from various sources which are in good, or fairly good, agreement with those calculated according to the revised formula. The observations at Cliffwood and New Southgate[3] were taken by the American Telephone and Telegraph Company and those at Karachi by the Indian Post Office.[4]

The series at San Diego[5] was taken by the Bureau of Standards, while the Marion and Nauen observations on the S. S. Dorset and Boonah[6] by the Marconi Company represent the averages taken from the observation curves of the two ships, one in March, 1922 and the other in July, 1923. Bordeaux changed its wave length from 23400 m to 19000 m, at about the time the Boonah sailed from Australia,

[3] Bell System Technical Journal **4**: 459. 1925.
[4] London Elec. **91**: 164. 1923.
[5] This JOURNAL **15**: 139, 1925.
[6] Jour. I. E. E. (London) **63**: 933. 1925.

and this change resulted in such an increase in the efficiency of the station that the observations on the two ships could not be fairly compared.

TABLE 2.—SOME CALCULATED AND OBSERVED FIELD INTENSITIES

SENDING STATION	RECEIVING STATION	f kc	λ km	d km	E μv/m Calculated	E μv/m Observed	
Nauen	Cliffwood, N. J.	23.8	12.6	6350	44	42	1922–1923
Marion	New Southgate, Eng.	25.8	11.6	5280	40	53	1923–1924
Rome	Karachi, India	28.0	10.7	5230	24	20	Nov., 1921, to Jan., 1923
Bordeaux	Karachi, India	12.8	23.4	5900	60	68	
Ste. Assise	Bureau of Stds.	20.6	14.5	6150	53	48	1923
Bordeaux	Bureau of Stds.	12.8	23.4	6160	67	71	1922
Buenos Aires	Bureau of Stds.	23.6	12.7	8300	30	37	1924
Cavite, P. I.	San Diego, Cal.	19.3	15.5	11800	2.7	2.0	Aug. 28–Sept. 22, 1924
Marion	S. S. Dorset and Boonah	25.8	11.6	8000	11	12	March, 1922, and July, 1923
				12000	2.7	3	
Nauen	S. S. Dorset and Boonah	23.8	12.6	8000	21	22	March, 1922, and July, 1923
				12000	5.4	5.5	
Bordeaux	S. S. Dorset	12.8	23.4	8000	37	33	March, 1922
				12000	13	10	

In a later paper the rest of the available data, both favorable and unfavorable to the formula, will be discussed.

SCIENTIFIC NOTES AND NEWS

On behalf of the American Geographical Society, presentations were made of the Cullum Geographical Medal to Dr. HARVEY C. HAYES, the Charles P. Daly Medal to Brig. Gen. DAVID L. BRAINARD at a joint meeting of the ACADEMY, Philosophical Society, and the Biological Society, on April 15.

Professor ERNEST COHEN, Director of the Vant' Hoff Laboratory, University of Utrecht, will address a joint meeting of the ACADEMY and several of its affiliated societies in the near future.

The following scientists will be in Washington; Dr. RUFUS L. GREEN, Professor of mathematics at Leland Stanford University, from April 24 to 30; Dr. WILLIAM MCPHERSON, professor of chemistry and dean of the graduate school of Ohio State University, from April 22 to 25; and Dr. E. L. NICHOLS of Ithaca, N. Y., from April 21 to May 16. All may be addressed at the Cosmos Club.